PATENT
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

HOU et al.

Application No. Unassigned

Filed: Herewith

For: NEGATIVELY CHARGED MEMBRANE

Art Unit: Unassigned

Examiner: Unassigned

PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT

1. A negatively charged microporous membrane comprising a porous substrate and a crosslinked coating, wherein the crosslinked coating is prepared from a polymer comprising an unsaturated monomer having a negatively charged group, a hydrophilic non-ionic unsaturated monomer, and at least one or more N-(hydroxyalkyl)- or N-(alkoxyalkyl)-acrylamide.

2. The negatively charged microporous membrane of claim 1, wherein the hydrophilic non-ionic unsaturated monomer is an acrylic monomer.

3. The negatively charged microporous membrane of claim 1, wherein the N-(hydroxyalkyl)- or N-(alkoxyalkyl)- acrylamide includes an alkyl group of 4 carbon atoms or less.

4. The negatively charged microporous membrane of claim 1, wherein the crosslinked coating includes a hydroxyl-rich material.

5. The negatively charged microporous membrane of claim 4, wherein the hydroxyl-rich material is a polysaccharide.

6. The negatively charged microporous membrane of claim 1, wherein said negatively charged group is a sulfonic or carboxylic acid.

7. The negatively charged microporous membrane of claim 2, wherein said acrylic monomer is an acrylate or acrylamide.

8. The negatively charged microporous membrane of claim 7, wherein said acrylic monomer is an acrylamide.

9. The negatively charged microporous membrane of claim 8, wherein said acrylamide is an alkylacrylamide.

10. The negatively charged microporous membrane of claim 9, wherein said acrylamide has a sulfonic acid group.

11. The negatively charged microporous membrane of claim 10, wherein said acrylamide is acrylamido-N-alkylsulfonic acid.

12. The negatively charged microporous membrane of claim 9, wherein said alkylacrylamide has a carboxylic acid group.

13. The negatively charged microporous membrane of claim 12, wherein said polymer includes a further acrylic monomer having a carboxylic acid group.

14. The negatively charged microporous membrane of claim 13, wherein said further acrylic monomer is an acrylate.

15. The negatively charged microporous membrane of claim 14, wherein said acrylate is β-carboxyethyl acrylate.

16. The negatively charged microporous membrane of claim 4, wherein said acrylic monomer is a hydroxyacrylic monomer.

17. The negatively charged microporous membrane of claim 16, wherein said hydroxyacrylic monomer is a hydroxyacrylamide or an hydroxyacrylate.

18. The negatively charged microporous membrane of claim 1, wherein said polymer includes an N-(alkoxymethyl) acrylamide.

19. The negatively charged microporous membrane of claim 5, wherein said polysaccharide is dextran.

20. The negatively charged microporous membrane of claim 1, wherein the polymer comprising an unsaturated monomer having a negatively charged group, a hydrophilic non-ionic unsaturated monomer, and at least one or more N-(hydroxyalkyl)- or N-(alkoxyalkyl)-acrylamide is prepared by employing a free radical initiator.

21. The negatively charged microporous membrane of claim 1 having a dynamic protein binding capacity of about 25 mg/ml lysozyme or more.

22. A negatively charged microporous membrane comprising a porous substrate and a crosslinked coating comprising negatively charged groups and amide-amide and amide-ester crosslinks.

23. The negatively charged microporous membrane of claim 1, wherein said porous substrate comprises a substrate polymer.

24. The negatively charged microporous membrane of claim 23, wherein said substrate polymer is selected from the group consisting of polyaromatics, polysulfones, polyolefins, polystyrenes, polyamides, polyimides, cellulose acetates, cellulose nitrates, polycarbonates, polyesters, and fluoropolymers.

25. The negatively charged microporous membrane of claim 24, wherein said substrate polymer is a polysulfone.

26. The negatively charged microporous membrane of claim 1, wherein said porous substrate is hydrophilic.

27. A process for preparing a negatively charged microporous membrane comprising a porous substrate and a crosslinked coating having negatively charged groups, the process comprising:
(a) providing a porous substrate;
(b) contacting said substrate with a polymer comprising an unsaturated monomer having a negatively charged group, a hydrophilic non-ionic unsaturated monomer, and at least one or more of a N-(hydroxyalkyl)- or N-(alkoxyalkyl)- acrylamide;
(c) curing the substrate obtained in (b) to obtain the negatively charged microporous membrane; and
(d) optionally, extracting the membrane obtained in (c) to remove extractable residue therein.

28. A process for preparing a negatively charged microporous membrane comprising a porous substrate and a crosslinked coating having negatively charged groups, the process comprising:
(a) providing a porous substrate;
(b) contacting said substrate with a polysaccharide and a polymer comprising an unsaturated monomer having a negatively charged group and an N-(hydroxymethyl)- or N-(alkoxymethyl)- acrylamide;
(c) curing the substrate obtained in (b) to obtain the negatively charged microporous membrane; and
(d) optionally, extracting the membrane obtained in (c) to remove extractable residue therein.

29. The process of claim 27, wherein said negatively charged group is a sulfonic or carboxylic acid.

30. The process of claim 27, wherein said unsaturated monomer having a negatively charged group is an acrylic monomer having a sulfonic or carboxylic acid group.

31. The process of claim 30, wherein said acrylic monomer having a sulfonic or carboxylic acid group is an acrylate or an acrylamide.

32. The process of claim 27, wherein the substrate is contacted in (b) with said polymer and a hydroxyl-rich material.

33. The process of claim 27, wherein said porous substrate comprises a substrate polymer.

34. The negatively charged microporous membrane prepared by the process of claim 27.

35. A device comprising the negatively charged microporous membrane of claim 1.

36. A process for separating positively charged material from a fluid, said process comprising placing said fluid in contact with the negatively charged microporous membrane of claim 1, so as to adsorb the positively charged material to said membrane.

37. The process of claim 36, wherein said positively charged material is a biomolecule.

38. A process for transferring biomolecules from an electrophoresis gel comprising contacting said electrophoresis gel with a membrane of claim 1 and transferring the biomolecules to the membrane.

39. The process of claim 38, wherein said biomolecule is selected from the group consisting of proteins, polypeptides, amino acids, and nucleic acids, and combinations thereof.

40. The process of claim 38, further including recovering the positively charged material adsorbed on the membrane.

41. A negatively charged microporous membrane comprising a porous substrate and a crosslinked coating comprising negatively charged groups and amide-amide and amide-ester crosslinks, wherein the amide-amide crosslink has the formula -C(=O)NH-R-NH C(=O)- and the amide-ester crosslink has the formula -C(=O)O-R-NH-C(=O)-, wherein R is a divalent radical.

42. The negatively charged microporous membrane of claim 41, wherein the divalent radical is an alkoxyalkyl radical.

43. The negatively charged microporous membrane of claim 42, wherein the alkoxyalkyl radical is $-CH_2-O-CH_2-$.

44. The negatively charged microporous membrane of claim 42, wherein the alkoxyalkyl radical is $-CH_2-CH_2-CH_2-O-CH_2-$.

45. The negatively charged microporous membrane of claim 41, wherein the crosslinked coating comprises a polymerized unsaturated monomer having a negatively charged group and a polymerized hydrophilic non-ionic unsaturated monomer.

46. The negatively charged microporous membrane of claim 45, wherein the hydrophilic non-ionic unsaturated monomer is an acrylic monomer.

47. The negatively charged microporous membrane of claim 45, wherein the monomer having a negatively charged group is an acrylic monomer.

48. The negatively charged microporous membrane of claim 41, wherein the negatively charged group is a sulfonic acid group or carboxylic acid group.